Strategies to Enhance Online Learning Teams

Team Assessment and Diagnostics Instrument

and Agent-based Modeling

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Background

Learning/Performance Challenges

Human Challenges

- Demands on individuals
- From learning perspective: complex skills and knowledge, limited time, lack of practice to develop automaticity

Solution Challenges

- Recurrent theme—getting more out of the people
- Need to do more with resources—effective, efficient
- Need to get engaged with other and learning activities/job tasks
- Target all three characteristics—Effective, Effective, Engaging

Designer Challenges

- Differences between Learning and Performance Strategies

Workplace Challenges

Technology Progress/Workplace Needs

1. Scientific/technology progress places new demands on workforce
2. Rapid technology advances require workforce to have ability to adapt to changing technologies
3. Technological progress has an impact not only on how we do things, but also how we think
   a. "Knowing" was once—being able to remember and repeat information
   b. "Knowing" is now—being able to find and use information
4. Current work tasks favor strong non-routine cognitive skills such as problem solving, abstract reasoning, communication, and collaboration
5. Learning goals need to focus towards helping students develop learning strategies and cognitive tools
6. Students need basic understanding about key subjects but also need to learn how to ask meaningful questions
7. Many work tasks are too complex and too large to be handled by a single individual

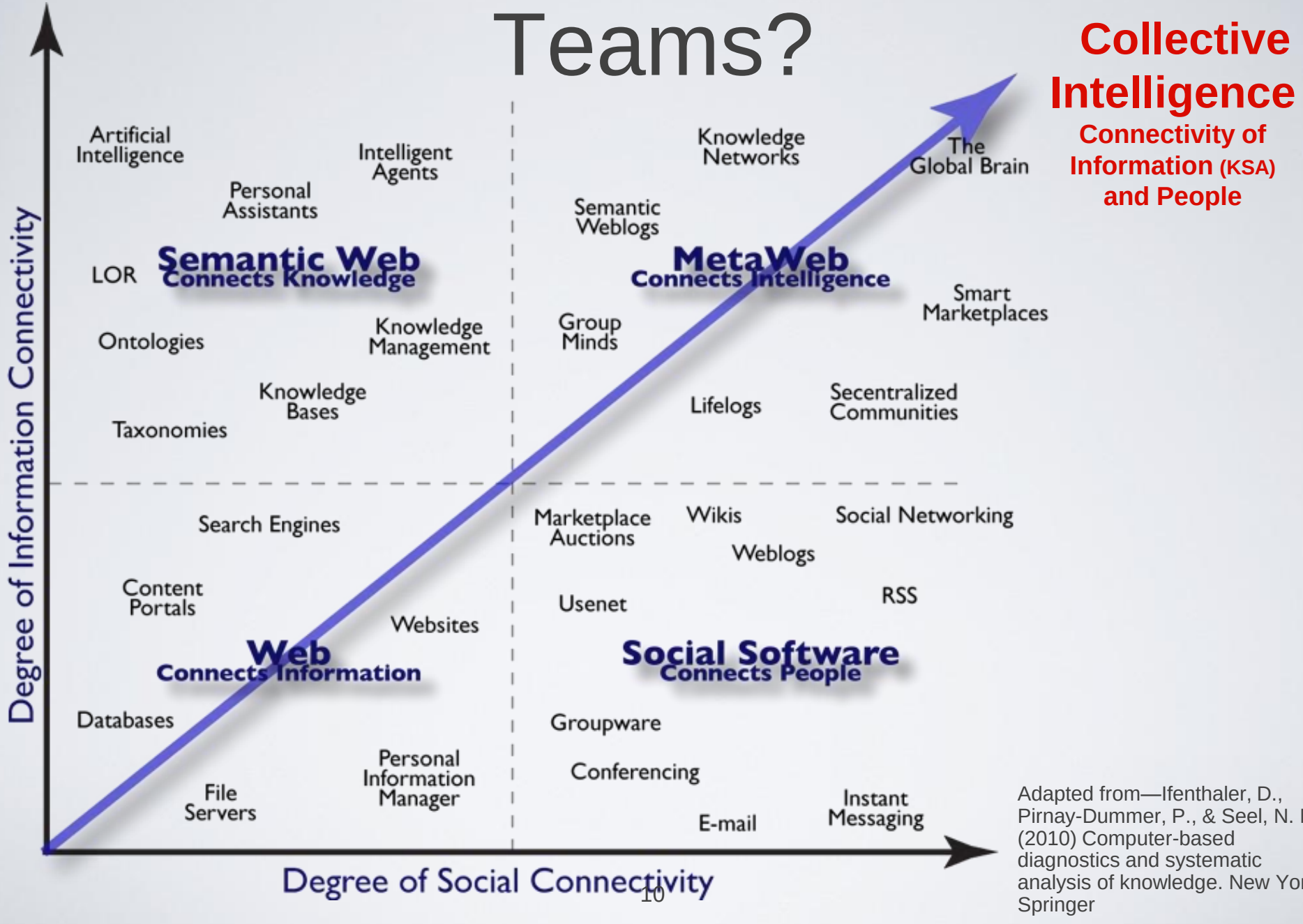
Viable Solution

1. Teams
   a. Formed for collective resources (e.g., knowledge, skills, and diverse expertise) are required to complete and solve complex tasks
2. Team Research—Understanding Team Behaviors
   a. Teams work effectively together when they think in similar ways
   b. Key indicator of team performance—degree team members share similar conceptualizations of problems and approaches
   c. Research had led to improved understanding about team behaviors
   d. Theoretical constructs (e.g., shared understanding, distributed cognition, shared knowledge, shared cognition) have been developed to better understand team

Broad Impact—Benefits of Theoretical Framework

1. Developing and Improving Teams
   a. Use a team cognition framework to systematically study aspects of instructional and performance strategies that affect team performance in complex problem-solving domains
   b. Theoretical framework can guide the design of effective learning activities (interaction strategies)
   c. Theoretical framework can inform our knowledge of teaming processes
   d. Working in teams has more benefits than just job performance
2. Using Teams for Learning
   a. Few instructional methods use teams as a salient characteristic
   b. Team Based Learning (TBL) specific instructional method

Where are we going with Teams?



Adapted from—Ifenthaler, D., Pirnay-Dummer, P., & Seel, N. M. (2010) Computer-based diagnostics and systematic analysis of knowledge. New York: Springer

Online Team Challenges/Solutions/Practice

Online Team Challenges

1. Forming
2. Roles
3. Expectations
4. Communication
5. Style
6. Intent
7. Feedback

Online Team Solutions

Solutions approach informed

- Anecdotal Data
- Evaluation Data Driven Decision-Making
- Modeling
- Experimental Research

Techniques for becoming informed

- Advanced/Emergent Performance (Learning) Assessment

TADI—HIMATT—ABM

Online Team Practice

1. **Development Needs**
   - Selection of solid development methods
   - Application of rigorous development standards
   - Insights from outside of development
2. **Research Needs**
   - Selection of solid research methods
   - Application of rigorous research standards
   - Insights from outside of research
3. **Bridging Research and Development** (examples at the end)
   - Decision-making Tools—make sense of research (models, algorithms)
   - Knowledge-making Tools—make sense of practice (learning and performance assessment tools, research instruments)

Inquiry & Measurement Strategy

Understanding Theoretical Framework

Team Cognition

Shared Mental Models

Tools Used to Understand [Decision-making & Knowledge-making]

Measuring

Assessing

Modeling

Understanding Online Teams

Team Cognition Framework

Team Cognition—Framework Value

1. Understand Teams
    a. TC has potential value as explanatory mechanism
2. Predictive Value
    a. Construct has potential to be a predictive variable in teams
3. Diagnosis Treatment
    a. Help to diagnose team dysfunction or team excellence
    b. Provide insight into how to solve issues
4. Facilitate Interventions
    a. Understanding the TC behind team performance should facilitate intervention design, development, and/or selection, in order to improve performance

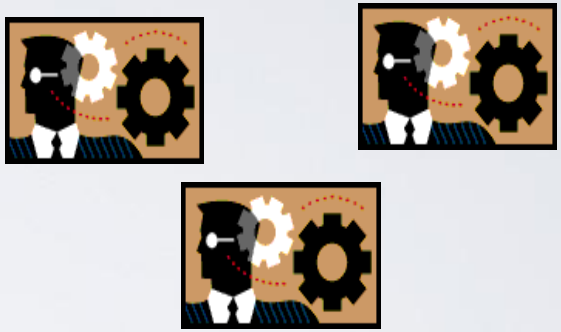
Team Cognition—Implications

Implications of Theoretical Framework

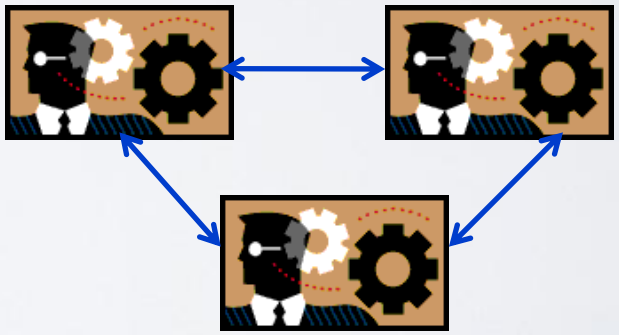
1. Team Cognition provides a framework to study performance and learning teams
2. Team Cognition framework provides the key factors that have an impact on team outcomes

Team Cognition—Concept

- More than the sum of the individual team members cognition



- Emerges from the interaction between individual cognition (each team member) and team process behaviors



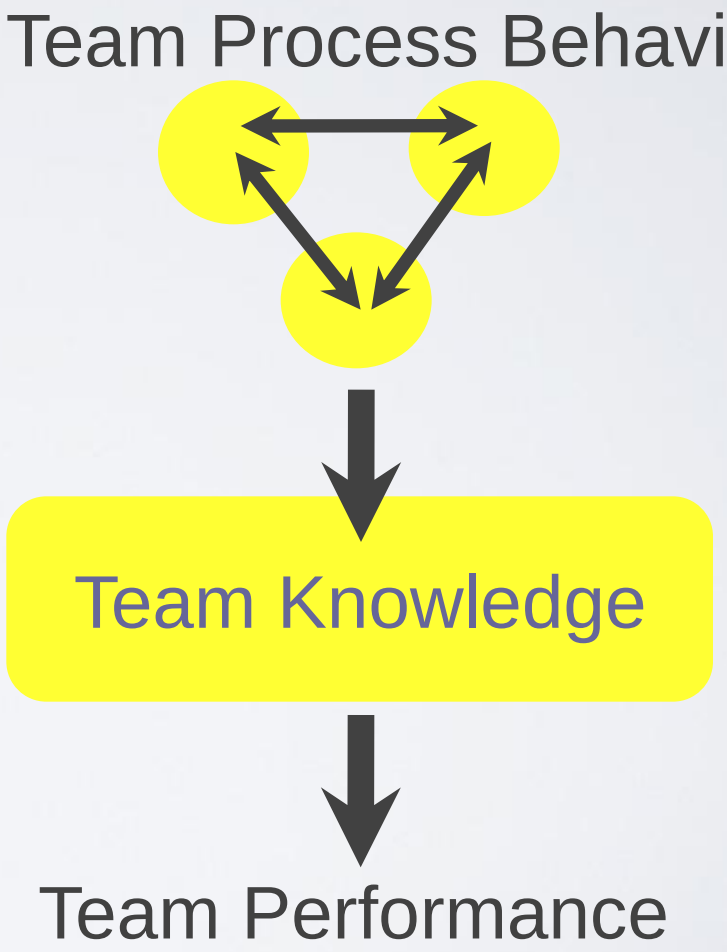
Team Cognition—Framework

Collective level

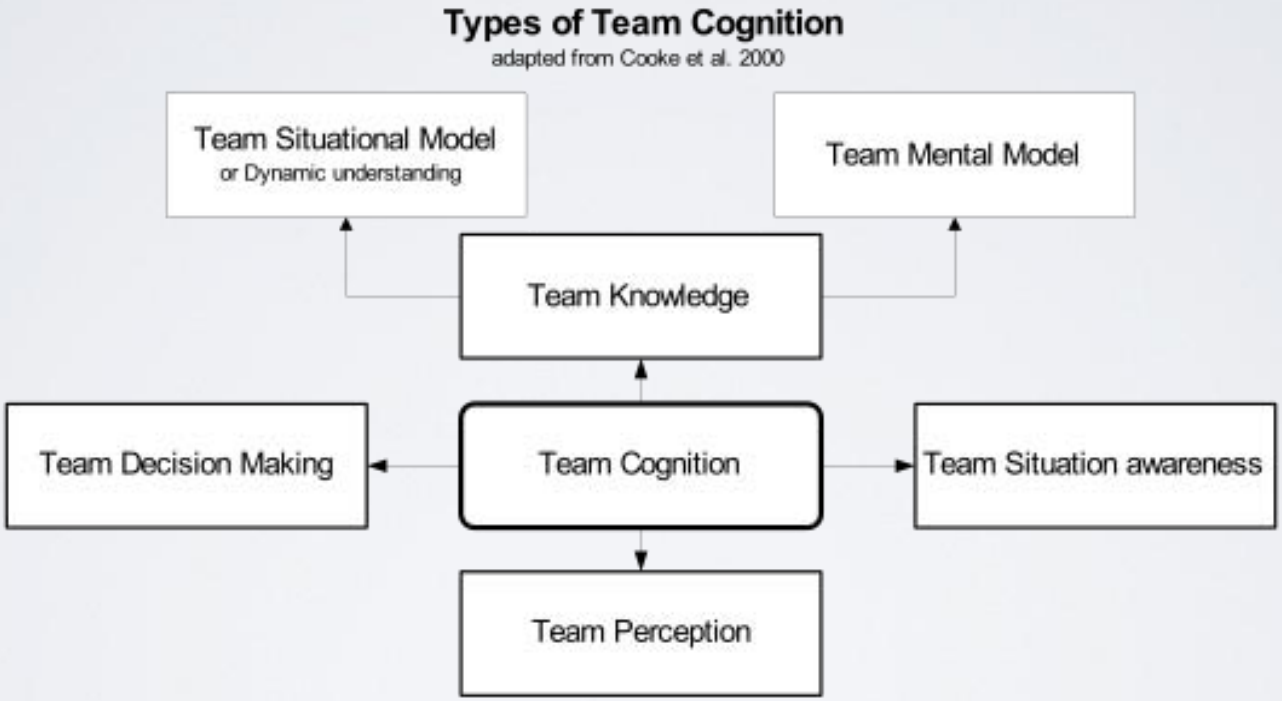
Individual knowledge

Holistic Level

Taskwork/Teamwork Knowledge
—Long-term & Fleeting



Team Cognition—Types



Operationalization of Theoretical Framework

Shared Mental Models

Mental Models—Concept

[aka: Collective cognition, team knowledge, team mental models, shared knowledge, transactive memory, shared mental models]

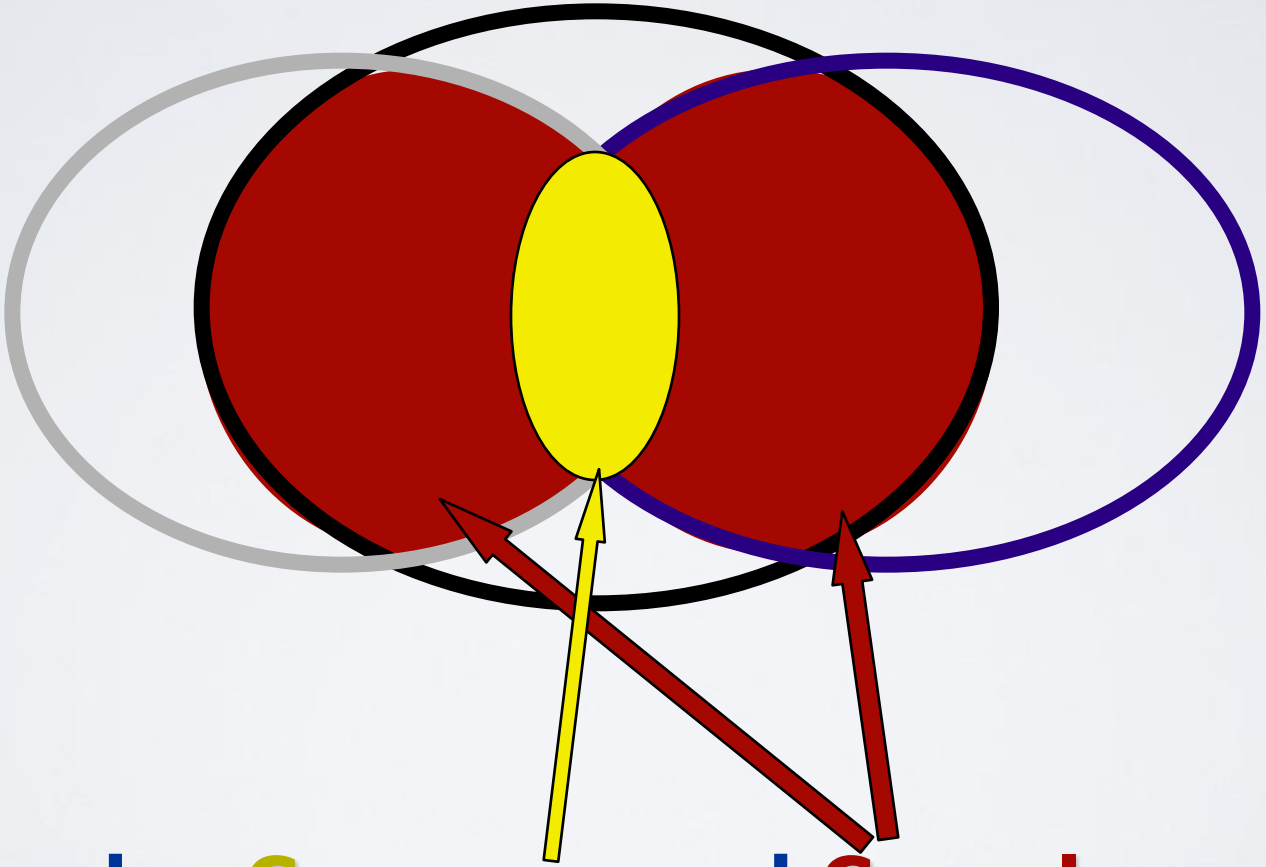
Mental Models

"Mechanism whereby humans generate descriptions of system purpose and form, explanations of system functioning and observed system state, and prediction of future system state" Rouse & Morris (1986)

Shared Mental Model—What do we mean by shared?

1. Shared or overlapping
   a. Situations where two or more team members having ‘some common knowledge’, but not necessarily ‘fully redundant’
   b. Implying a knowledge base associated with the work
2. Similar or identical
   a. Team members holding similar, if not identical, knowledge
   b. Most directly applying to shared attitudes and beliefs.
3. Compatible or complementary
   a. Not need shared or similar knowledge, but knowledge must lead team members to draw similar expectations for performance
4. Distributed
   a. Adequate coverage for task knowledge
   b. Knowledge being effectively apportioned across members

Shared Mental Model—
"Shared" Knowledge

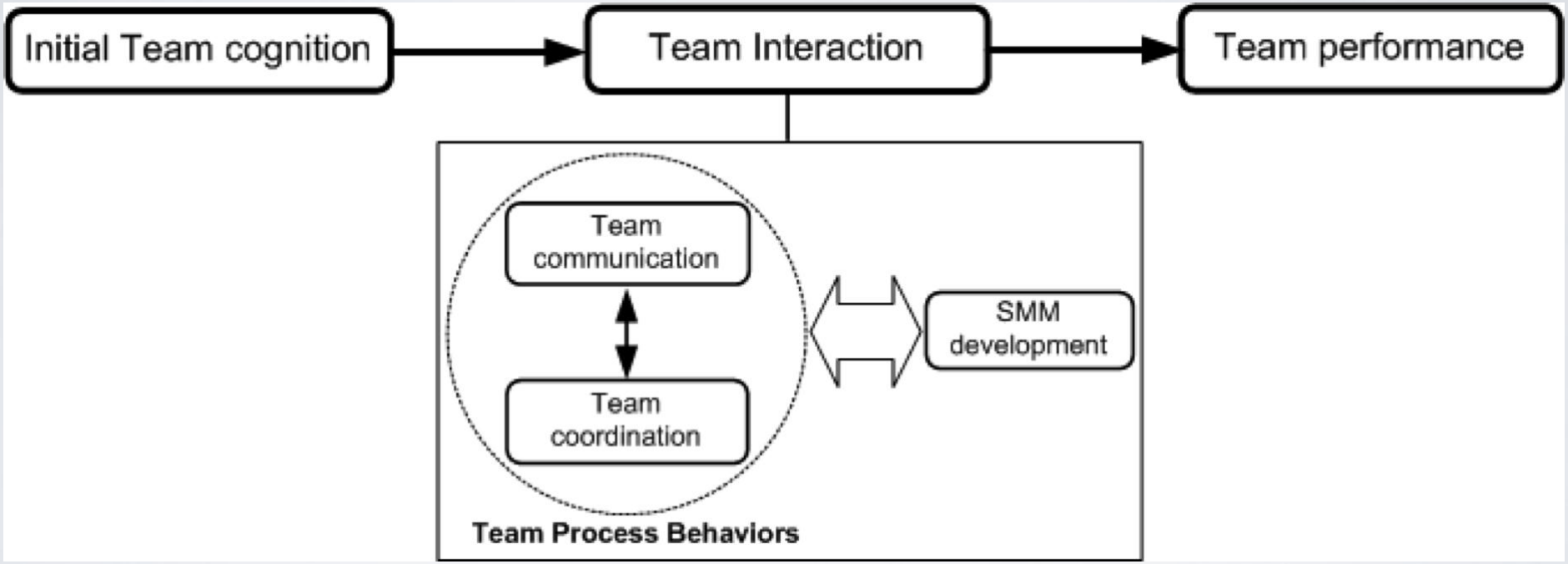


Shared = Common and Complementary

Shared Mental Model—Shared Knowledge Types

1. Task Knowledge—domain specific
2. Team Knowledge—5 factors
    a. Team Knowledge
    b. Team Skills
    c. Team Attitudes
    d. Team Dynamics
    e. Team Environment

Shared Mental Model—Link to Team Performance



Tools to Understand Online Teams

Measuring Team Cognition

Measuring Team Cognition—Why Measure

1. Assessment of team performance or effectiveness (criterion or dependent measures) often taken for granted
2. Outcome measures of team performance do not typically reveal why performance is effective or ineffective
3. Process measures of team behavior are often subjective and lack reliability and validity
4. Team cognition is assumed to contribute to team performance, and especially for growing number of cognitive tasks
5. Understanding the team cognition behind team performance should inform interventions (design, training, selection) to improve that performance

Assessing Team SMM

Assessing Team SMM

1. Capture conceptual representations of individual mental models
2. Use analytical methods to compare mental models
   a. Show relationships among individuals (team) or for a single individuals — at one point or over time
3. Analytical comparisons are carried out to represent differences and change of cognitive function
4. Research Focus
   a. Measure Individual Knowledge, Determine Shared Knowledge
   b. Measure Team Interactions, Determine Team Patterns
   c. Measure Individual & Team Performance, Determine Effects of Team Cognition
5. Research Goal
   a. What are the patterns and underlying mechanism of Team Cognition
6. Workplace Goal
   a. Improve Team Performance

Techniques to Measure Shared Knowledge

1. Traditional—measuring concept relatedness
   a. Card sorting, cognitive interviewing, MDS, Pathfinder, surveys, casual maps (Langan-Fox, Code, Langfield-Smith, 2000; Trochim, 1989)
   b. Concept Mapping—Statistical analysis & Descriptive analysis

2. Emerging Methods
   a. Analysis Constructed Shared Mental Models (AC-SMM) Methodology (Johnson & O'Connor, 2004, 2008)
   b. Team-related Knowledge SMM Instrument (TADI) (Johnson et. al, 2007)
   c. Surface, Matching, and Deep Structure (SMD) Methodology (Ifenthaler, 2006)
   d. Model Inspection Trace of Concepts and Relations (MITOCAR) Methodology (Pirnay-Dummer, 2006)

Assessing Team SMM—TADI

Team Assessment and Diagnostics Instrument (TADI)

Team-related Knowledge SMM Instrument (Johnson et. al, 2007)

TADI—Team Knowledge Factors

1. Team Knowledge
   - Knowledge about team members and tasks that they need to perform
   - Teammates knowledge, Task knowledge
2. Team Skills
   - Knowledge about team members abilities associated with successful job performance
   - Communication skills, Interpersonal skills, Leadership skills, Skills to deal with conflict and team cohesion
3. Team Attitudes
   - Knowledge about team members internal state that influences team members' choices or decision to act in a certain way under particular circumstances
   - Shared belief, Shared value
4. Team Dynamics
   - Knowledge about team members dynamic processes of team coordination and team cohesion
   - Team coordination, Team cohesion
5. Team Environment
   - Knowledge about team members external conditions affecting the foundation of the team mental model
   - Technology, Organization, Synchrony & Geographic dispersion

Developing Team SMM Assessment Techniques—HIMATT Study

Highly Integrated Model Assessment Technology & Tools (HIMATT) (Johnson et. al, 2009)

- Surface, Matching, and Deep Structure (SMD) Methodology (Ifenthaler, 2006)
- Model Inspection Trace of Concepts and Relations (MITOCAR) Methodology (Pirnay-Dummer, 2006)

Similarity Analysis

HIMATT based on graph theory, set theory, model theory, and similarity distribution measures and measurement of change

Similarity Dimension	Similarity Indices
Structure	1-Surface
	2-Graphic
	3-Structure
	4-Gamma
Semantic	5-Concept
	6-Proposition
	7-Balance

1-sum of all propositions; 2-diameter of spanning tree (quantity of links for the shortest path for most distant notes—range of conceptual knowledge); 3-not graphical but mere structure; 4-density of vertices

HIMATT Indices

1. **Surface measure** — compares the number of vertices within two graphs—values for surface complexity
2. **Graphical matching** — diameters of the spanning trees—indicator for range of conceptual knowledge Measure for structural complexity only
3. **Structural matching measure** — compares complete structures of two graphs
   Measure is necessary for testing all hypotheses that make assumptions about general features of structure (e.g., assumptions which state that expert knowledge is structured differently from novice knowledge)
4. **Gamma** (density of vertices measure) — quotient of terms per vertex Since both graphs, (a) those which connect every term with each other term (everything with everything), and (b) graphs which only connect pairs of terms can be considered weak models, a medium density is expected for most good working models
5. **Concept matching** — compares the sets of concepts (vertices) within a graph to determine the use of terms — Counts how many concepts are alike Measure is especially important for different groups operating in the same domain (e.g. using the same textbook). It determines differences in language use between the models
6. **Propositional matching** — value compares only fully identical propositions (concept-link-concept) between two graphs—semantic similarity
7. **Balanced semantic matching** — uses concepts and propositions to match the semantic potential between the knowledge representations

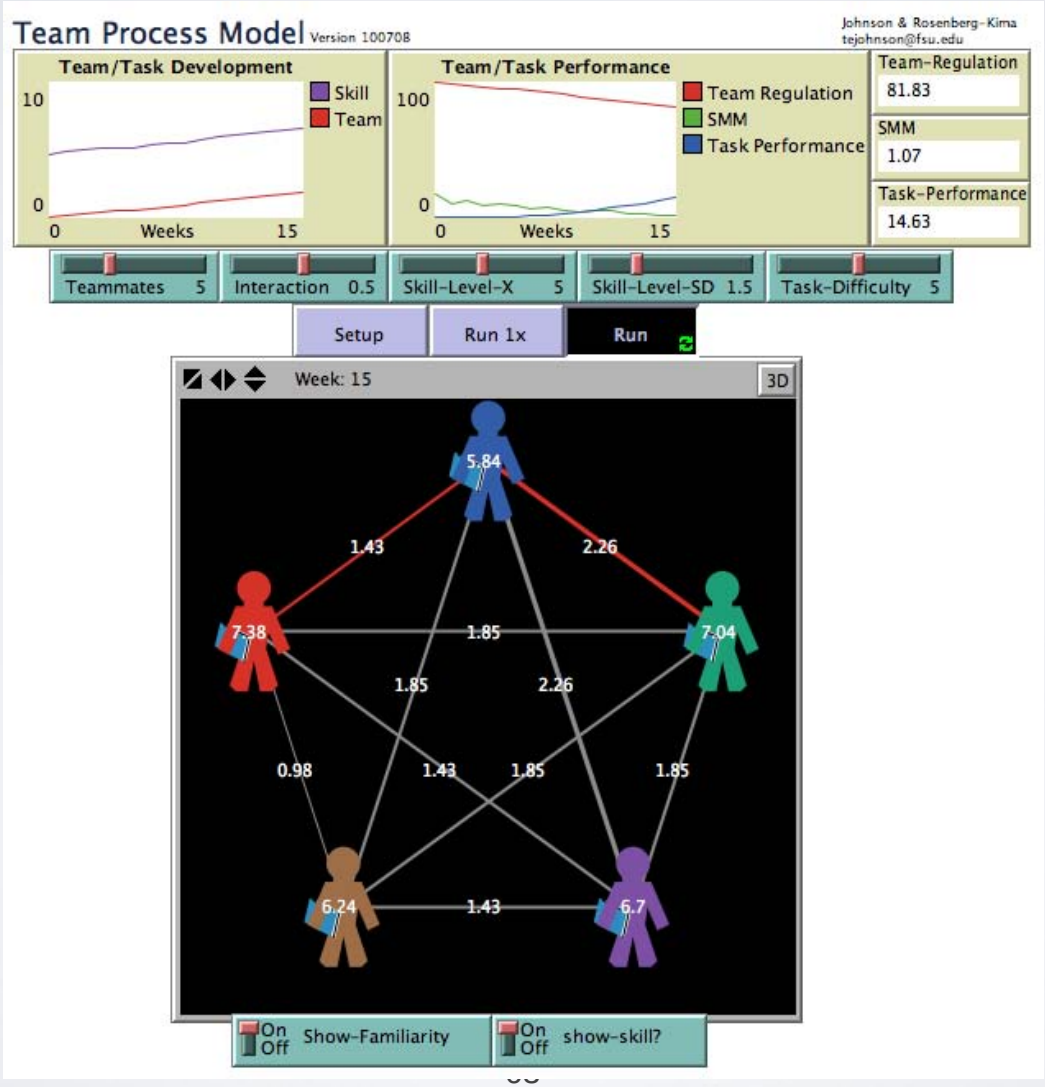
Implications and Benefits—Team Assessment

Future Work

- Team Readiness Assessment—realtime, cyclical nature of job tasks (performance/recoil) (performance episodes)—how ready are we?
- Learning feedback—how am I doing? how are we doing?
- Decision-making tool—what is the state of things? where do we go?
- Team self diagnosis—where are we at? what to focus on?
- Learning & Performance Interventions—want is needed? what types of tasks are critical to focus on?

Modeling Team Processes

Agent-Based Modeling



Implications and Benefits—Team Modeling

- Decision making tool
  - What size of team given specific team and task parameters
- Diagnostic tool
  - How might our team perform given our team characteristics
- Planning Tool
  - How much will out team get out of a specific learning task?
  - What is the cost of having too many teammates?

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Q&A

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